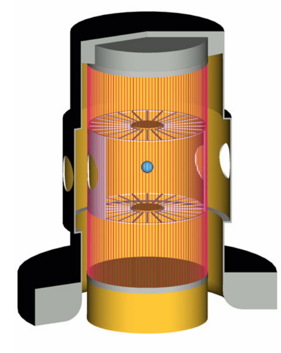
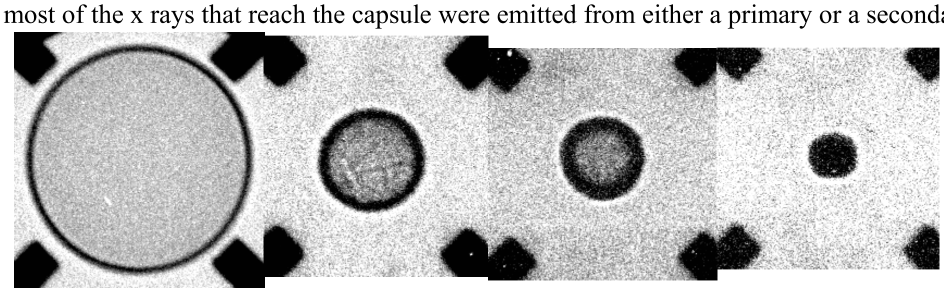
1673 News Notes: June 2002 Edition

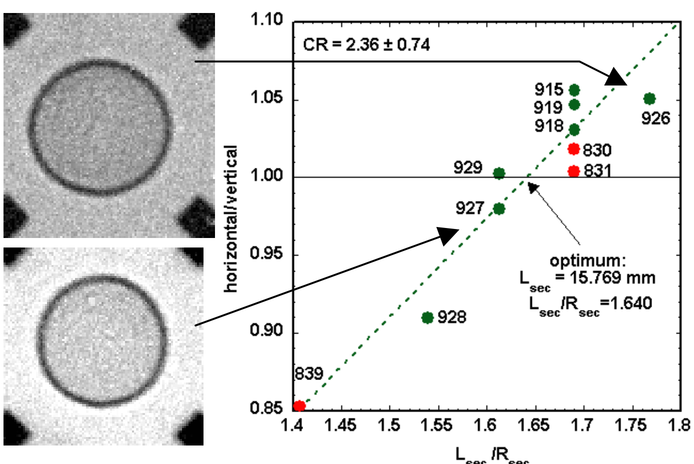


Fusion Capsule Implosion Experiments: Round 2

In the March 2002 News Notes, we reported some results from fusion capsule implosion experiments conducted in November 2001. In May and June 2002, a second round of experiments studying capsule implosions was headed by Guy Bennett (grbenne@sandia.gov), Mike Cuneo (mecuneo@sandia.gov) and Roger Vesey (ravesey@sandia.gov). These experiments studied 2.1 mm diameter, thin-walled (57 micrometer thick) plastic capsules in the double z-pinch-driven hohlraum configuration pictured to the upper right. Approximately 17,000,000 Amperes of current was passed through two wire arrays located on each end of a cylindrically shaped container ("hohlraum") containing the plastic capsule. The wires in each array form plasma that is compressed to the axis by strong magnetic fields, where the "z-pinch" plasmas each radiate 45-50 TW of x rays (by contrast, the world's power plants produce about 4 TW of continuous power). To prevent x rays from either z pinch from reaching the capsule directly, two 6.75 mm diameter tungsten disks are placed on axis, held in place by radial beryllium spokes. The walls surrounding the z pinches (the "primary hohlraums") are coated with a thin layer of gold, as are the walls of the "secondary" hohlraum surrounding the capsule. Most of the x rays emitted by the z pinches are absorbed by the walls of the primary or secondary hohlraums, which are heated and reemit the x rays. Thus, in this geometry most of the x rays that reach the capsule were emitted from either a primary or a secondary hohlraum wall. By varying the height and radius of the secondary hohlraum it is possible to adjust the uniformity of the radiation reaching the surface of the capsule so that the capsule retains a nearly spherical shape as it implodes.



Using the new off-axis final optics assembly of the Z-Beamlet laser (May 2002 News Notes), x-ray images of the capsule implosions were made at different times relative to the peak x-ray power from the z pinches. Sample images from tests with a 16.25 mm tall, 20 mm diameter secondary hohlraum are shown above. The capsules in these tests remain nearly spherical in shape even as the diameter of the capsule shrinks, indicating that the radiation incident on the surface of the capsules is very nearly the same everywhere on the capsule. To determine the optimum size of the secondary hohlraum, the height of the secondary hohlraum was varied to obtain non-uniform capsule implosions. By examining these implosions, it is possible to determine the optimum geometry of the secondary hohlraum.



How does the symmetry of the radiation vary with the height of the secondary hohlraum? If we imagine that we used a very, very tall hohlraum, then the radiation from the z pinches would effectively only come from the top and bottom of the hohlraum, and radiation would hit the capsule only near its very top and bottom. The capsule would then be "pole-hot". Similarly, if the height was too short, most of the radiation hitting the capsule would hit near the equator of the spherical capsule, making it "equator-hot". Examples of pole-hot and equator-hot capsule implosions are shown to the left in the top and bottom images, respectively. Also shown to the left is a graph of the vertical and horizontal compression as a function of the geometry, indicating that the optimum secondary height is 15.77 mm. Though the analysis of these data is still ongoing, these experiments have demonstrated that we can control the even mode symmetry of capsule implosions entirely through geometry.

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